IQRA NATIONAL UNIVERSITY PESHAWER

FINAL TERM PAPER

ENVIRONMENTAL MANAGEMENT

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Q: NO.01

Wastewater Treatment:

- ‘‘Wastewater treatment is a process used to remove contaminants from wastewater or sewage and convert it into an effluent that can be returned to the water cycle with minimum impact on the environment, or directly reused. The latter is called water reclamation because treated wastewater can be used for other purposes. The treatment process takes place in a wastewater treatment plant (WWTP), often referred to as a Water Resource Recovery Facility (WRRF) or a Sewage Treatment Plant (STP). Pollutants in municipal wastewater (households and small industries) are removed or broken down.”

- There are two treatment methods for wastewater

aerobic wastewater treatment

Aerobic wastewater treatment systems use oxygen-feeding bacteria, protozoa, and other specialty microbes to clean water (as opposed to anaerobic systems that do not need oxygen). These systems optimize the naturally occurring process of microbial decomposition to break down industrial wastewater contaminants so they can be removed.

Anaerobic wastewater treatment

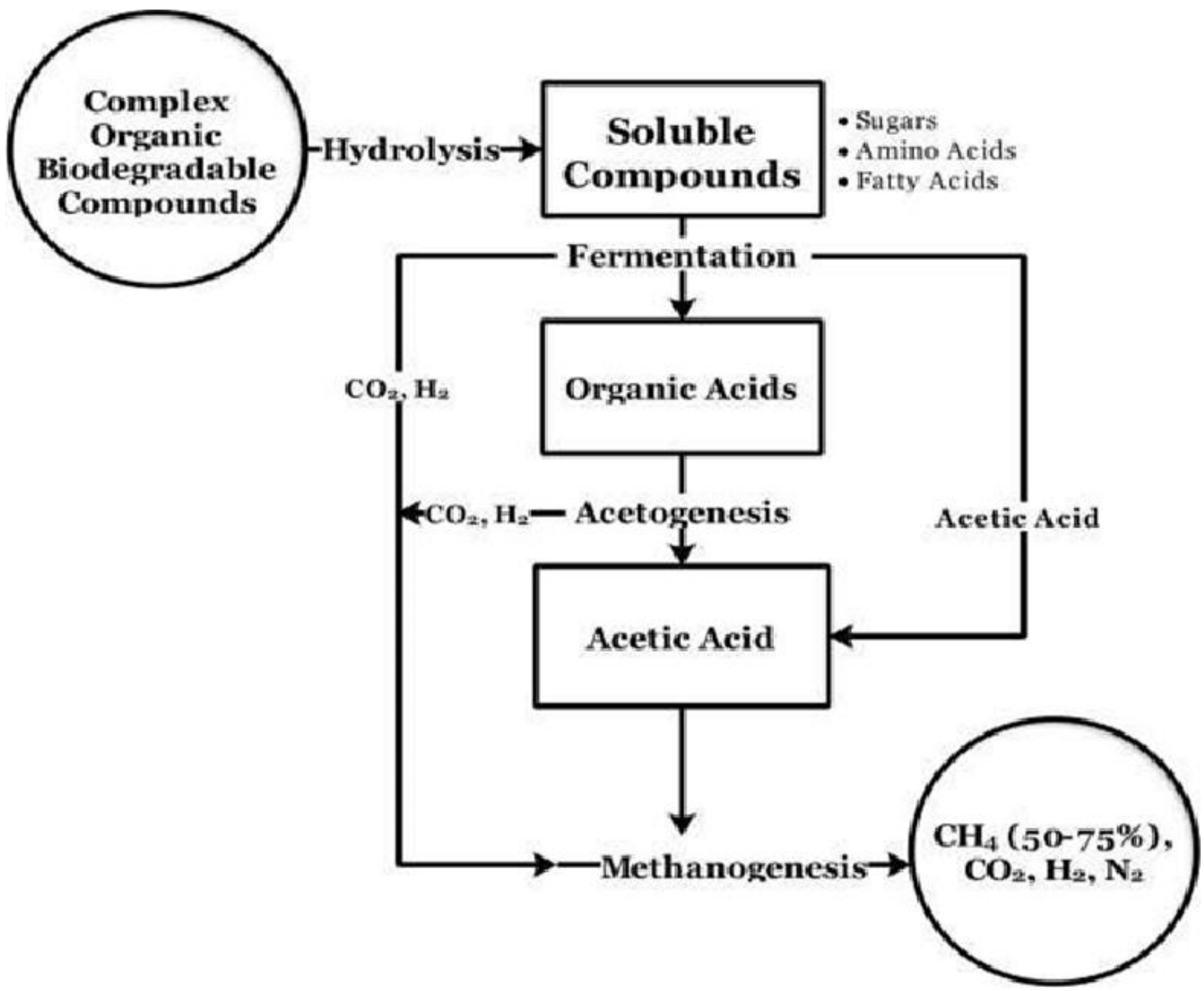
Anaerobic wastewater treatment is a biological process where microorganisms degrade organic contaminants in the absence of oxygen. In a basic anaerobic treatment cycle, wastewater enters a bioreactor receptacle. The bioreactor contains a thick, semi-solid substance known as sludge, which is comprised of anaerobic bacteria and other microorganisms. These anaerobic microorganisms, or “anaerobes,” digest the biodegradable matter present in the wastewater, resulting in an effluent with lower biological oxygen demand (BOD), chemical oxygen demand (COD), and/or total suspended solids (TSS), as well as biogas byproducts.

I convincing the client for Anaerobic wastewater treatment for housing society which is best for the future of accommodate up to a million residents. I can select Anaerobic wastewater treatment on the following.

Anaerobic wastewater treatment

Anaerobic wastewater treatment is used to treat a variety of industrial effluent streams from agricultural, food and beverage, dairy, pulp and paper, and textile industries, as well as municipal sewage sludge and wastewater. Anaerobic technologies are typically deployed for streams with high concentrations of organic material (measured as high BOD, COD, or TSS), often prior to aerobic treatment. Anaerobic treatment is also used for specialized applications, such as treatment of waste streams with inorganics or chlorinated organics, and is well-suited for treating warm industrial wastewater.

Anaerobic processes are also frequently used to ferment aerobic sludge and fluid organic waste.



Process of anaerobic wastewater treatment:

The anaerobic wastewater treatment process consists of two stages:

An acidification phase followed by a methane production phase, with both processes occurring in dynamic equilibrium. In the initial acid-forming phase, anaerobes break down complex organic compounds into simpler, short-chain volatile organic acids.

The second phase, known as the methane-production phase, consists of two steps: acetogenesis, where anaerobes synthesize organic acids to form acetate, hydrogen gas, and carbon dioxide; and methanogenesis, where the anaerobic microorganisms then act upon these newly-formed molecules to form methane gas and carbon dioxide. These byproducts can be reclaimed for use as fuel, while the wastewater can be routed for further treatment and/or discharge.

Depending upon specific application needs and facility requirements, anaerobic digester systems can be designed as single- or multi-stage units, meaning that they can be configured with a separate acidification tank and bioreactor unit.

Common types of anaerobic wastewater treatment systems include the following:

Anaerobic lagoons

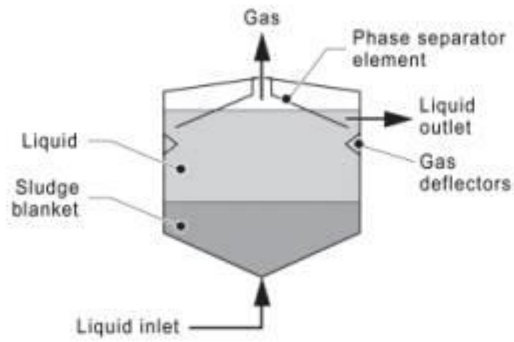
Anaerobic lagoons are large man-made ponds, typically ranging between 1-2 acres in size, and up to 20 feet deep. They are used widely for treatment of agricultural wastewater resulting from meat production, as well as treatment of other industrial wastewater streams, and as a primary treatment step in municipal wastewater treatment. Wastewater is typically piped into the bottom of the lagoon, where it settles out to form an upper liquid layer, and a semi-solid sludge layer. The liquid layer prevents oxygen from reaching the sludge layer, allowing a process of anaerobic digestion to break down the organic materials in the wastewater. On average, this process can take as little as a few weeks, or up to six months to bring BOD/COD levels to the target range. Anaerobic bacteria favor certain environmental conditions, such as warm water temperatures (85-95° F) and a near-neutral pH, therefore, maintaining optimal conditions will enhance the rate of anaerobic microorganism activity, resulting in a shorter wastewater detention time. The rate of anaerobic respiration can also be limited by a number of factors, including fluctuations in BOD/COD concentration, and presence of substances such as sodium, potassium, calcium, and magnesium.

Anaerobic sludge blanket reactors

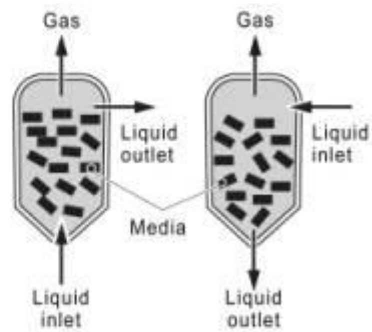
Sludge blanket reactors are a type of anaerobic treatment where wastewater is passed through a free-floating “blanket” of suspended sludge particles. As the anaerobes in the sludge digest the organic constituents in the wastewater, they multiply and collect into larger granules that settle to the bottom of the reactor tank, and can be recycled for future cycles. The treated effluent flows upward and out of the unit. Biogases resulting from the degradation process are collected by collection hoods throughout the treatment cycle.

Anaerobic sludge blanket reactors are available in a few different forms, including:

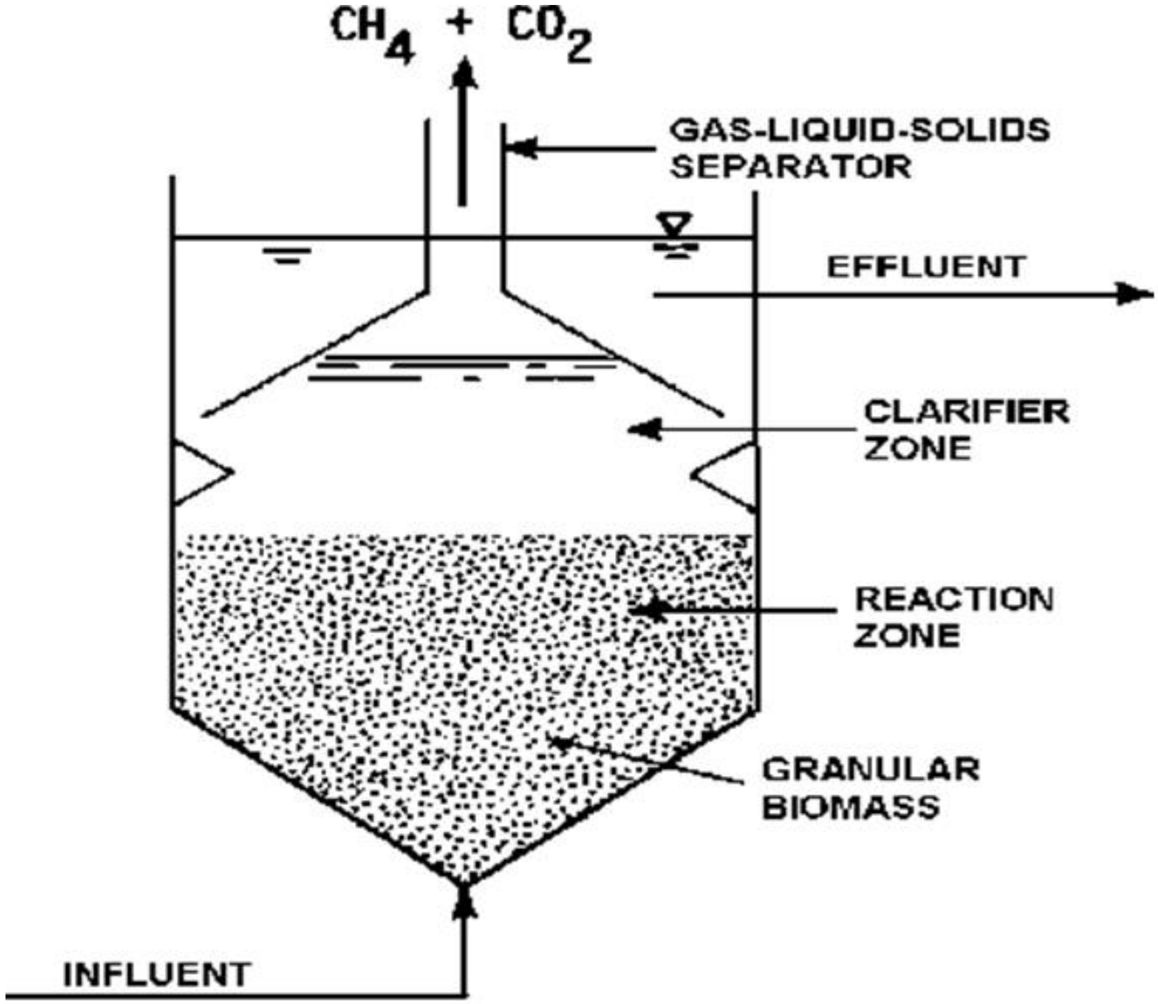
- **Upflow anaerobic sludge blanket (UASBs):** In UASB treatment, wastewater is pumped into the bottom of a UASB bioreactor with upward flow applied. This causes the sludge blanket to float as the wastewater flows through it.



- **Expanded granular sludge beds (EGSBs):** EGSBs are very similar to UASB technology, with the key distinguishing factor being that the wastewater is recirculated through the system to promote greater contact with the sludge. They are also typically taller than UASBs, and influent flows are sustained at a higher velocity. As a result, EGSBs are able to treat streams with higher loads of organics comparative to UASB systems.



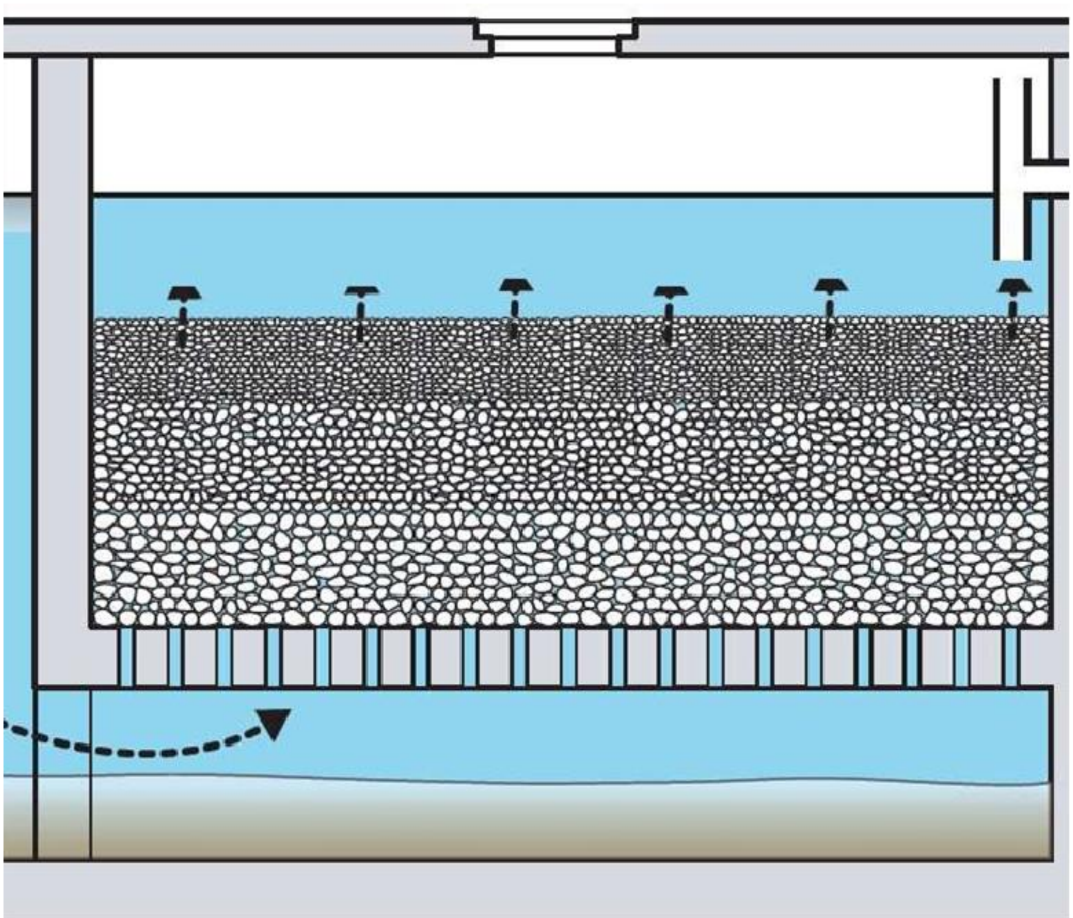
- **Anaerobic baffled reactors (ABRs):** ABRs are constructed with semi-enclosed compartments that are separated by alternating baffles. The baffles interrupt the smooth flow of the wastewater stream, encouraging greater contact with the sludge blanket as it travels from the reactor inlet to outlet.



UPFLOW ANAEROBIC SLUDGE BLANKET REACTOR

Anaerobic filter reactors

Anaerobic filter reactors are comprised of a reactor tank outfitted with a fixed filter medium of some kind. Anaerobic microorganisms are allowed to establish themselves on the filter media, forming what is known as a biofilm. Filter media vary from one system to the next, with common materials including plastic films and particles, as well as gravel, pumice, bricks and other materials. New filter media must be inoculated with anaerobes, and the biofilm may take several months to become established to the point that it is ready for treatment at full capacity. During treatment cycles, the wastewater stream is passed through the filter media, which serves to capture particles from the stream, while also providing ample surface area for exposing anaerobes in the biofilm to the organic materials present in the stream. Filter reactor performance must be carefully monitored over time, as the filter media will eventually become clogged with excess biofilm and particulate buildup, requiring maintenance steps such as backwashing and cleaning to maintain optimal performance.



Application

Anaerobic purification is implemented in various sectors. In the food sector, this technique is regularly used to reduce the high cost of aerobic waste purification by partially breaking down the organic load and converting into biogas.

Advantages and Disadvantages of a Trickling Filter

Advantages

- High degree of waste stabilization
- Low production of excess biological sludge that can be directly dried on sludge drying bed without further treatment
- Low nutrition requirements
- No oxygen requirement
- Production of valuable by product, methane gas
- Organic loading is not limited
- Less land requirement
- Non feed conditions for few month do not affect adversely to the system (can work seasonally)

Disadvantages

- Incomplete break-down of organic compounds
- No thorough nutrient removal
- Again later aerobic purification with nutrient removal is often needed
- Most efficient purification in the mesophilic range (30- 37°C) whereby the influent must be heated in most cases
- Less robust system with regards to toxicity and inhibition
- Risk of odor problems\

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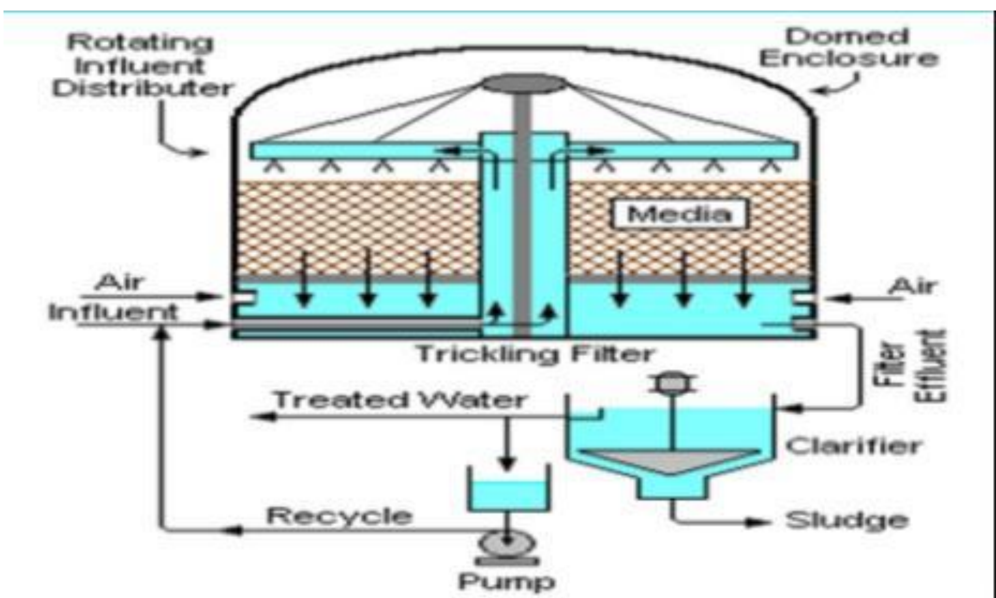
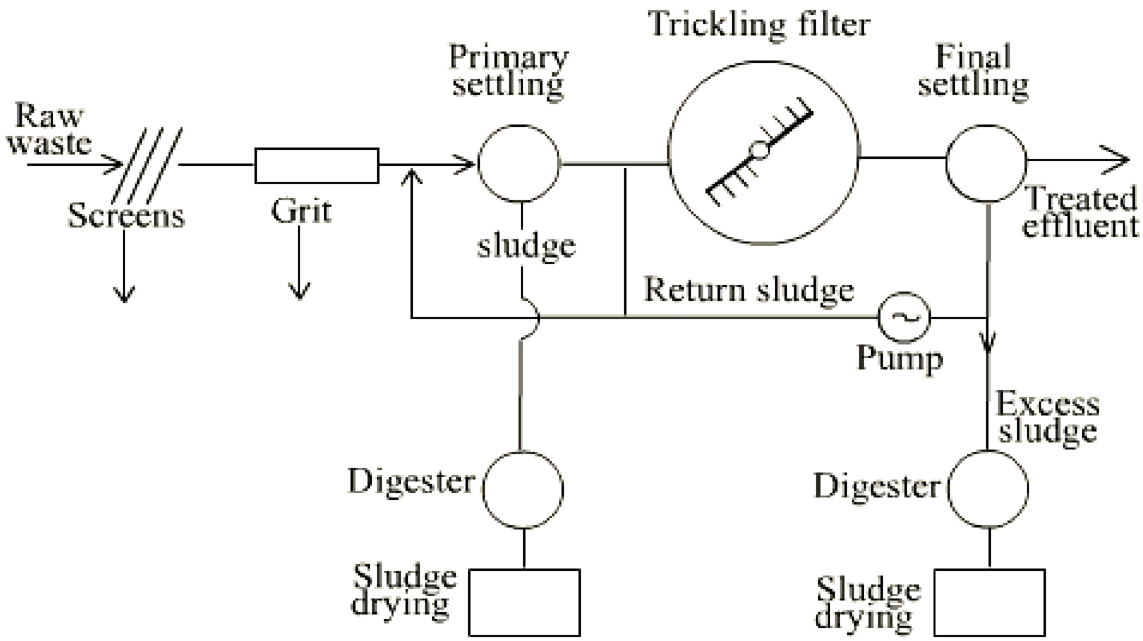
Trickling Filters

Trickling Filters are a unique type of fixed film biological treatment. In a trickling filter, the microorganisms used to treat the wastewater are attached, or fixed, to a medium as they contact the wastewater. These micro-organisms form a slime growth on the medium known as zoogleal film.

- Wastewater applied to a trickling filter has already passed through a mechanical bar screen and/or primary clarifiers where the majority of settleable and floatable solids are removed.
- Wastewater is distributed over the top of the medium and slowly trickles through it. The biological growth is attached to the media.
- This is in contrast to “suspended growth” biological treatment, where the micro-organisms float freely in the wastewater.
- Trickling filter effluent always passes through a secondary clarifier or sand filter to allow for capture of solids generated as a result of treating the wastewater.
- The sludge (solids) from a final clarifier should be pumped back to the primary clarifier or to a sludge thickener for further treatment.



Flow sheet of a trickling filter system



Trickling filter treatment process

The trickling filter treatment process occurs through the biological degradation of organic material by bacteria and micro-organisms contained in the zoogleal film on the filter media. These micro-organisms primarily reduce the carbonaceous biochemical oxygen demand (cBOD) of the wastewater; however, they can also be utilized to reduce ammonia nitrogen (NH3-N) through the process of "nitrification''

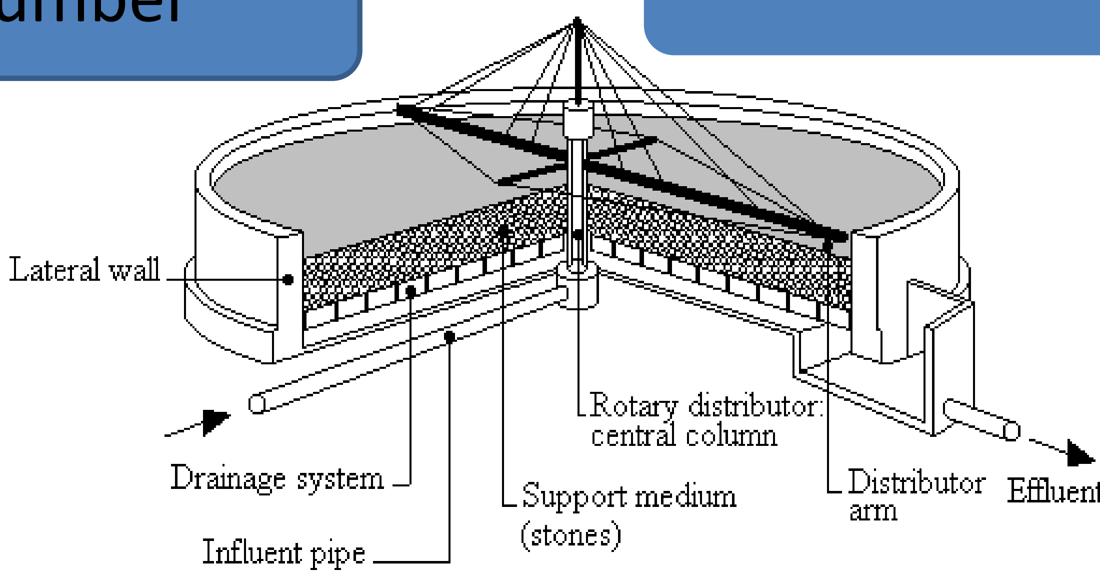
- Sewage flow enters at a high level and flows through the primary settlement tank
- The supernatant from the tank flows into a dosing device, often a tipping bucket which delivers flow to the arms of the filter
- The flush of water flows through the arms and exits through a series of holes pointing at an angle downwards
- This propels the arms around distributing the liquid evenly over the surface of the filter media
- Both absorption and adsorption of organic compounds and some inorganic species by the layer of microbial bio film
- The filter media is typically chosen to provide a very high surface area to volume

- Passage of the waste water over the media provides DO which the bio- film layer requires for the biochemical oxidation of the organic compounds and releases CO_2 gas, water and other oxidized end products
- As the bio film layer thickens, it eventually sloughs off into the liquid flow and subsequently forms part of the secondary sludge
- Other filters utilizing higher-density media do not produce a sludge that must be removed, but require forced air blowers and backwashing

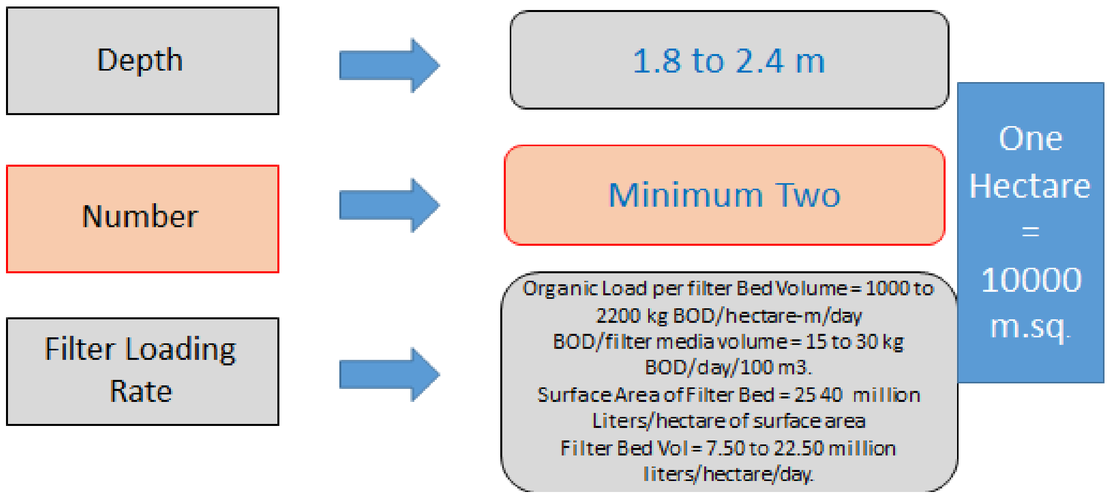
Trickling Filters Design

Filter Loading Rate

Number



Depth



Design Equations

Generally trickling filter design is based on empirical relationships to find the required filter volume for a designed degree of wastewater treatment. Types of equations:

1. NRC equations (National Research Council of USA)
2. Rankins equation
3. Eckenfilder equation
4. Galler and Gotaas equation

NRC and Rankin's equations are commonly used. NRC equations give satisfactory values when there is no re-circulation, the seasonal variations in temperature are not large and fluctuations with high organic loading. Rankin's equation is used for high rate filters.

NRC equations: These equations are applicable to both low rate and high rate filters. The efficiency of single stage or first stage of two stage filters, E_2 is given by

$$E_2 = \frac{100}{1+0.44(F_{1.BOD}/V_1.Rf_1)^{1/2}}$$

Where,

E2= % efficiency in BOD removal of single stage or first stage,

F1.BOD= BOD loading of settled raw sewage in single stage of the two-stage filter in kg/d,

V1= volume of first stage filter, m3,

Rf1= Recirculation factor for first stage.

Efficiency Estimation:

$$E = \frac{Y_i - Y_o}{Y_i} X\ 100$$

Where,

Yi = Influent BOD load to TF

Yo = Effluent BOD from TF.

Recirculation Factor Calculation:

$$F = \frac{1 + R}{(1 + 0.1R)1^2}$$

Where,

R = Recirculation percentage

Advantages and Disadvantages of a Trickling Filter

Advantages of a Trickling Filter

1. **Low Energy Requirements:**
   - ➢ Trickling filters do not typically require additional energy-consuming equipment such as aeration blowers.
2. **Waste Sludge Easy to Dewater:**
   - ➢ Sludge and solids from a trickling filter are primarily composed of the sloughed off biological slime layer.
     - This type of sludge tends to settle and dewater easier than waste activated sludge from conventional activated sludge plants.
3. **Low Maintenance Requirements**:
   - ➢ Since there are a limited number of moving parts, trickling filters typically require minimum maintenance.
4. **Consistent Effluent Quality:**
   - ➢ Trickling filters perform extremely reliably at low or consistent loadings.
     - Trickling filter technology is a simple, reliable process.
5. **Resistant to Toxins and Shock Loads:**
   - ➢ Trickling filters have the ability to handle and recover from shock loads since they are not a complete mix system.
     - A toxic "slug" will only effect the portion of the filter that it is sprayed on, thus allowing the remainder of the filter to continue to operate normally.
     - Recirculation of filter effluent back through the filter acts to dilute any shock loads which are introduced to the unit.
6. **Ease of Operation:**
   - ➢ Trickling filters do not require a high level of sophisticated operation in order to provide a reasonable effluent.

Disadvantages of a Trickling Filter

1. **Odors and Nuisance Organisms:**
   - ➢ Excessive organic loading or inadequate ventilation can lead to anaerobic decomposition in the filter media which can cause objectionable odors. For covered filters, a forced-air ventilation system and odor control of the exhaust is usually provided. Operators should always check for atmospheric hazards before entering.
     - Filter flies (Psychoda) and other insects can flourish around trickling filters if housekeeping is not maintained or if the filter media moisture is not adequate.

2. **Potential for Clogged Media:**
   - Excessive sloughing off of the media slime layer can cause portions of the filter media to become clogged, resulting in inefficient treatment removal and poor effluent quality. Seasonal sloughing will be apparent from the increase in secondary sludge production.
3. **Cold Weather Can Cause Freezing:**
   - Icing of the distributor arm orifices or spray nozzles is a common problem during winter months due to the low hydraulic loading onto the filters.
4. **Lack of Adjustment:**
   Trickling filters do not have features which allow them to be quickly adjusted for a rapid increase in loading. In addition, trickling filters cannot be fine-tuned to achieve a high level of treatment.
5. **Pumping Costs:**
   It may be necessary to pump the wastewater to a higher elevation so the flow can go out through the distributor. Additionally, recirculation of wastewater may be necessary to achieve sufficient wetting of the media.

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Renewable energy :-

Renewable energy is energy produced from sources that do not deplete or can be replenished within a human's life time. The most common examples include wind, solar, geothermal, biomass, and hydropower. This is in contrast to non-renewable sources such as fossil fuels.

Renewable energy from waste water sludge

Sewage sludge contains significant amounts of nitrogen ranging from 1-6% and 0.1-2% of phosphorous and traces of selenium and copper, making it a cheap vital source for plant growth. Sludge originates partly from sewers and partly from microorganisms during treatment process. Sludge recycling is considered as one of the most environmentally sustainable process for the improvement of land quality due the presence of nutrients as well as it is safer for the aquatic life.

USE IN AGRICULTURE:

At present, application of sludge to agriculture seems to be a most controversial but an inexpensive technique of sludge disposal. Application of sewage sludge to agriculture has proven advantageous and inexpensive for Eco cycling nutrients for land reclamation or land reuse

Researchers have put a lot of their attention Sludge as forest vitalizes or forest fertilizers and have attracted attention of companies towards it. As the Sludge if dried and pallets if made from them and spread all across can fulfill nitrogen scarcity and acidification due to intense forestry. Pellets from ash may be used for peat land due to its phosphorus contents

However, several observations have been made on the future use of sludge as sludge from sewage in cases does not prove beneficial. Some of the observations are mentioned as:

1. During different studies, Sludge analysis of samples indicated that some of the samples have high concentration of at least one metals while some had low concentrations giving a birth to metal supply for such sludge's.
2. The cost of measuring and treatment is high
3. The phosphorous contained in sludge varies and is different than the chemically precipitated phosphorous which is beneficial and safe for the land and the environment.
4. Most of the researches are of the view that an alternative path of sludge disposal should be implemented rather than using it in agriculture because it may lead to different food related diseases due to the presence of lead.

In contrast, Sludge agricultural use has a more effective sewage, such as:

1. binding with hard waste and excavation and storage;
2. entering a landfill of solid waste;
3. simultaneous training on sewage treatment only on the waste land.

Use as an energy source:

Globalization and the discovery of technology and production capabilities with high energy consumption rates ensure a predictable limit of energy resources based on fossil fuels. The world and the city of borrowing and the creation of food and support for food can be strengthened by the use of electricity. Despite the strong consequences of powerful businesses - like a global researcher offering perfect health for many years.
Global renewable energy distribution as per actual status:
Wind, 40%
Hydro, 32%
Biomass, 19%

Sewage Sludge to Energy <3%
Other > 6%
Renewable Energy Generation Sewage sludge can also be used to reduce the impact on climate change. Sewage sludge is a byproduct of the inevitable and inevitable sewage treatment. This sheep is produced all over the world and has made remarkable progress around the world. Sewage sludge is an inexpensive, renewable organic material and is suitable for the production of energy through various procedures and techniques.
The potential to generate renewable energy from sludge is huge. As wastewater treatment costs increase, access to renewable and cheap energy will be more important. Of course, sludge electricity is not totally free, but the raw material is exempt from the donation of many small donors. If you add solar and other renewable energy facilities to the treatment plant, you can keep the waste management costs of wastewater to a minimum.

Use Biogas production

Biogases production is already a popular method for energy production from the outside treatment of gastritis. Bacteria Methane (60-65%), use carbon dioxide (35-40%), and use toxic elements that use the body's physical contact. Hydrogen sulfide and water are like water and buckets are produced often used in the manufacture of boilers or CPRs. For example, in many wastewater treatment plants, anaerobic digestion facilities are being created to provide 90% of the site's energy through CHP. If CO_2 is also eliminated, biogas can be used in other applications, such as vehicle fuels. Trains, buses, taxis and some private vehicles work with Swedish biogas. Anaerobic digestion also reduces the solid mud content by up to 30%, which reduces the energy costs associated with transport.
The decomposition of organic matter, both animal and vegetable, produces millions of m3 of methane in the form of marsh or biogas gas each year. It is almost identical to the natural gas that the oil companies extracted from the ground and that many of us use to heat their homes and cook their meals. Many nations have been constantly building anaerobic digestion plants for years, which generate electricity from methane, liquid manure, sewage and waste.